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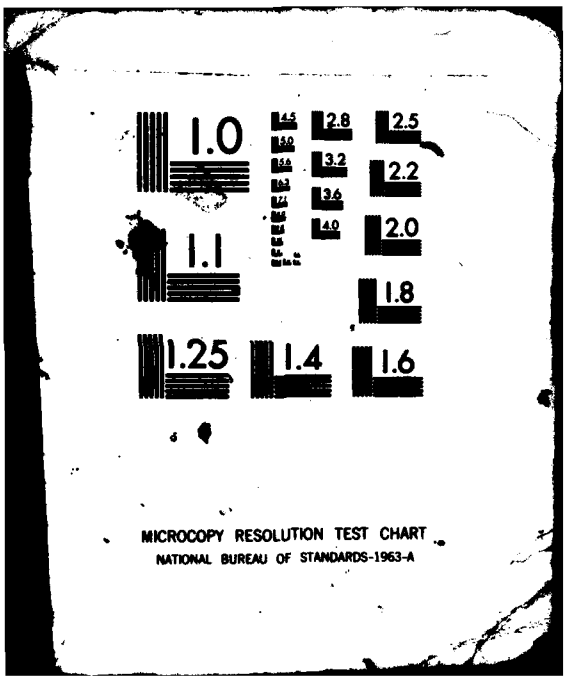
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DOT/FAA/CT-82/77

Identification of Exit Taxiways (Retroreflective Markers Only)

Larry W. Hackler

Prepared By
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June 1982

Interim Report

U.S. Department of Transportation
Federal Aviation Administration
Systems Research & Development Service
Washington, D.C. 20590

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16. Abstract

This project is being performed in response to an SRDS request to perform a more extensive evaluation and inservice test of a method using surface retroreflective markers for identifying short-radius exit taxiways (low-speed exits). The markers were installed at the Atlantic City (Federal Aviation Administration Technical Center) Airport. The evaluation provided additional information to help insure that the system will be acceptable to users. This report describes the results and gives plans for conducting the inservice test.

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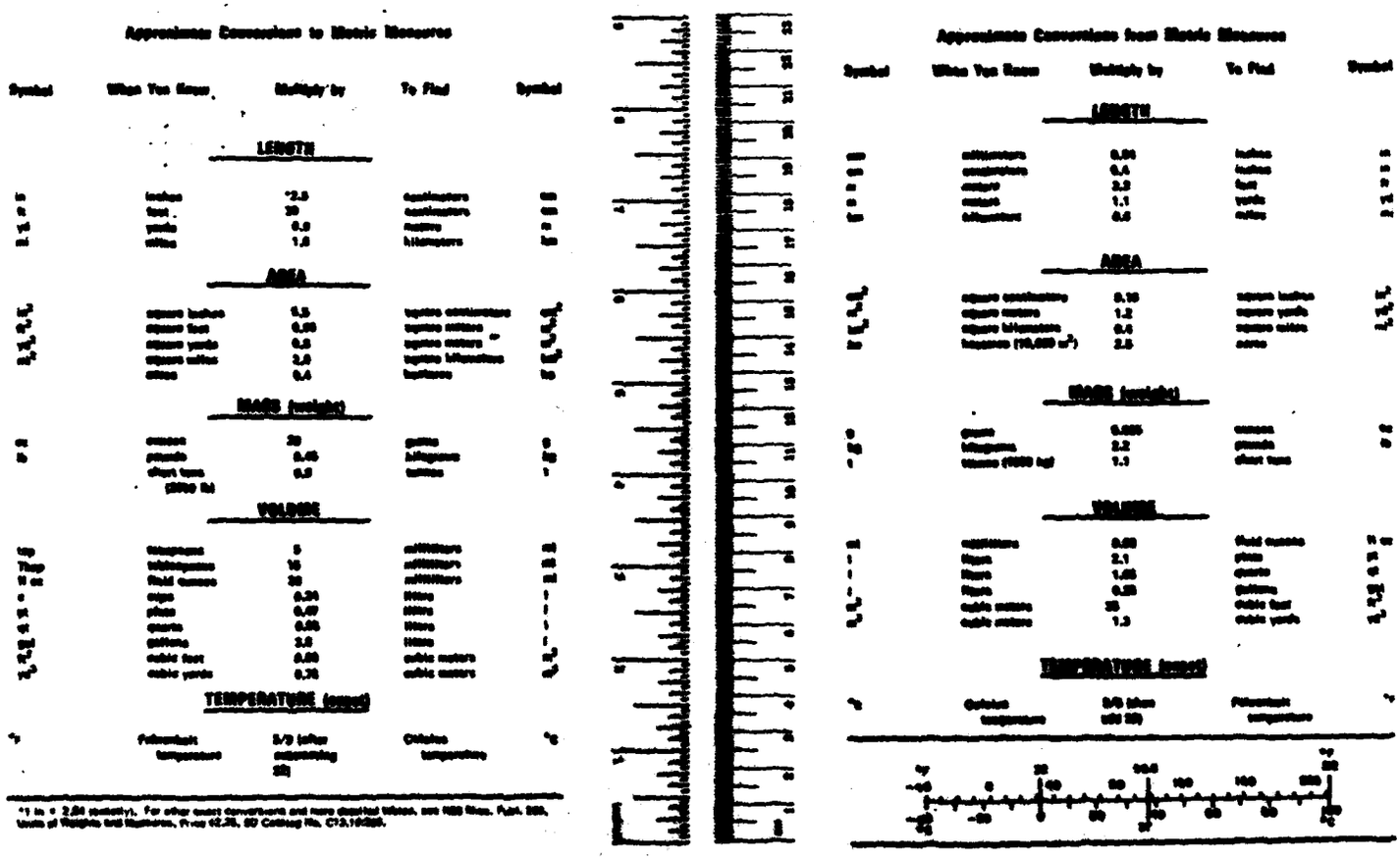

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INTRODUCTION

PURPOSE.

The purpose of this project is to perform an evaluation to include an inservice test of a technique using surface retroreflective markers for identifying short-radius exit taxiways ("low-speed" exits). The markers are intended for use at night and under reduced visibility at airports that cannot afford centerline lights. They are also intended to be used at airports that require a backup for their centerline lights. A preliminary investigation of this concept was completed at the Federal Aviation Administration (FAA) Technical Center and reported in NAFEC Technical Center Letter Report, NA-80-24-LR, "Taxiway Turnoff Lights," February 1980.

This report describes the results of a more extensive evaluation at the Technical Center of the retroreflective markers used to identify short-radius exit taxiways. Also the report provides a brief description of the plans for inservice testing.

BACKGROUND.

The work described in this interim report was performed in response to AFS 9550-1, Request Number 200-79-10. It is being accomplished under Technical Program Document Number 08-493, Subprogram 081-502, Project 540, "Identification of Exit Taxiways (Retroreflective Markers Only)." The project manager and author of this report is Larry W. Hackler, ACT-410, and the program manager is Thomas H. Paprocki, ACT-410.

Taxiway lighting and marking has the function of providing guidance between the runway and the apron (reference 1). A critical function of this system is to enable the pilot to expeditiously exit from the runway to a taxiway.

Short-radius exit taxiways have always been difficult to identify at night and under low visibility conditions. This was confirmed by a review of reports contained in the Aviation Safety Reporting System from May 1, 1978, through March 31, 1981. Pilots have often exited runways onto closed taxiways, closed runways, or even unpaved areas. Near collisions have occurred because of difficulty pilots had in finding exit taxiways. When traffic is heavy or when weather conditions make operations difficult, confusion in identifying the exits can result in major problems for controllers and pilots. Methods used to help the pilot find the exit taxiway include double blue taxiway edge lights, large taxiway identification signs, and green centerline taxiway lights ("high-speed" exits). These methods have been expensive or ineffective, sometimes both. For an excellent history of the lighting and marking of exit taxiways, see reference 2. In 1966 the International Civil Aviation Organization Visual Aids Panel recommended extending the green taxiway centerline lights onto the runway. This recommendation has not been adopted by the United States for short radius exit taxiways because of concern over the possible confusion of "low-speed" and "high-speed" exits. The use of a green-green-yellow color pattern was recommended to differentiate between short- and long-radius exit taxiways in a Technical Center report (reference 3).

An attempt is being made to provide a method that is both effective and inexpensive (compared to other methods using lights) by use of retroreflective markers similar

to those used on highways. The retroreflective markers are placed on an arc leading from the runway centerline to the taxiway centerline. The retroreflective markers are a combination of green and yellow color to eliminate confusion with a long-radius exit taxiway. The pilot should be able to identify the retroreflectors approximately 500 feet before reaching the exit taxiway. Near to or at the exit, visual cues from the regular taxiway lighting will serve to provide the necessary maneuvering guidance.

EVALUATION.

The retroreflective markers were installed on runway 4/22 at the FAA Technical Center (Atlantic City Airport). Runway 22 exits identified were D (Delta) and B (Bravo) (22/D and 22/B). Runway 4 had only B exit identified (4/B). Exit taxiway for runway 4 used 12.5 foot (4 meter) spacing of retroreflectors along the curve while the remaining exits used 25 foot (8 meter) spacing (figure 1).

The first retroreflector for exit taxiway 4/B (runway 4 and taxiway B) was placed at the point where the taxiway centerline marking begins to curve from the runway centerline. Exit taxiways 22/B and 22/D did not have this first retroreflector installed.

Pilot comments and opinions were used to refine the system recommended in reference 3 before installation at another airport for inservice testing.

FAA Technical Center test pilot comments were obtained after making several approaches or high-speed taxi maneuvers to the exits. Questionnaires were also completed by itinerant general aviation, commuter, and air carrier pilots using the airport.

RESULTS

Observations of Airport Airside Branch (ACT-410) personnel indicate that, during reduced visibility (approximately 1/8 mile), it is necessary to extend the retroreflectors to the centerline to enable the pilot to identify the exit taxiway. Also, the effectiveness of the retroreflector spacing was much better at 12.5 feet (4 meters) than 25 feet (8 meters). Table 1 is a summary of the 27 pilot responses. Some of the questionnaires did not respond to the question on exit taxiways. Also some questionnaires contained responses applicable to more than one exit. Under the "All" EXIT USED CATEGORY, each questionnaire is counted only once even though the responses were applicable to more than one exit. The appendix is a copy of the questionnaire which includes questions on another related project.

TABLE 1. PILOT RESPONSES

Exit Used	No Help	Some Help	Great Help	Spacing (ft)	First Retroreflector	Number of Responses
All	4%	29%	67%	—	—	24
22/B	0%	20%	80%	25	Missing	10
22/D	0%	33%	58%	25	Missing	12
4/B	0%	0%	100%	12.5	Present	11

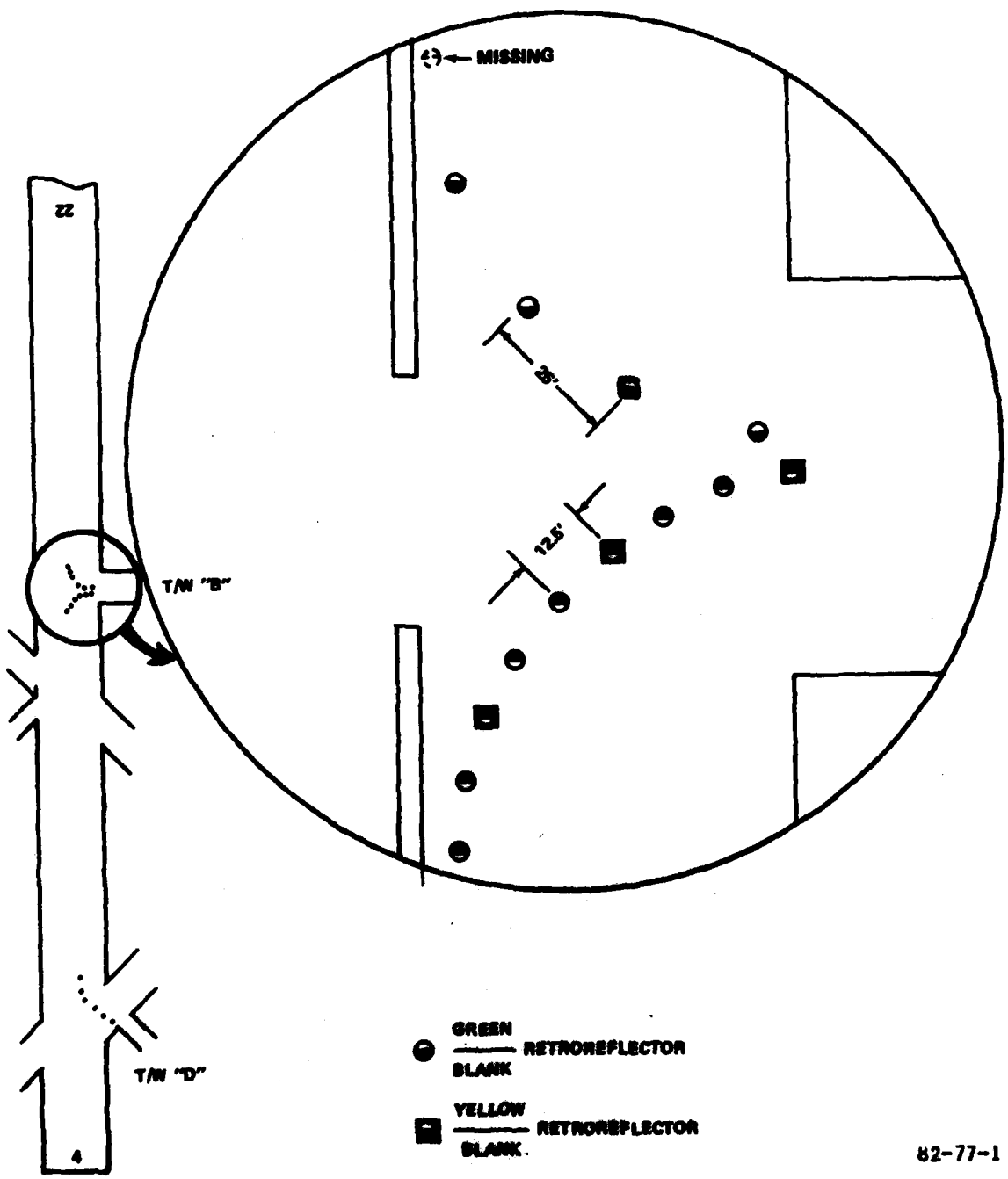

FIGURE 1. RETROREFLECTOR CONFIGURATION AT ACY

CONCLUSIONS

The unidirectional retroreflectors should be placed so that they have a cord interval of 12.5 feet (4 meters). The first retroreflector should be located on the arc where it is tangent to the runway centerline or where the taxiway centerline begins to curve from the runway centerline.

An inservice test is planned at Bader Field (Atlantic City) from early spring 1982 through late fall 1982. Approximately six exits will be marked with retroreflectors. Exit taxiways will include one 45-degree, two 90-degree, two 110-degree, and one 135-degree exit taxiway angles (figure 2).

REFERENCES

1. Douglas, C. A., Taxiway Guidance, Report No. DOT/FAA/RD-81/87, September 1981.

2. Douglas, C. A., Lighting and Marking of Exit Taxiways, FAA Report No. FAA-RD-78-94, August 25, 1978.

3. Hackler, L. W., Taxiway Turnoff Lights, FAA Report NA-80-24-LR, February 1980.

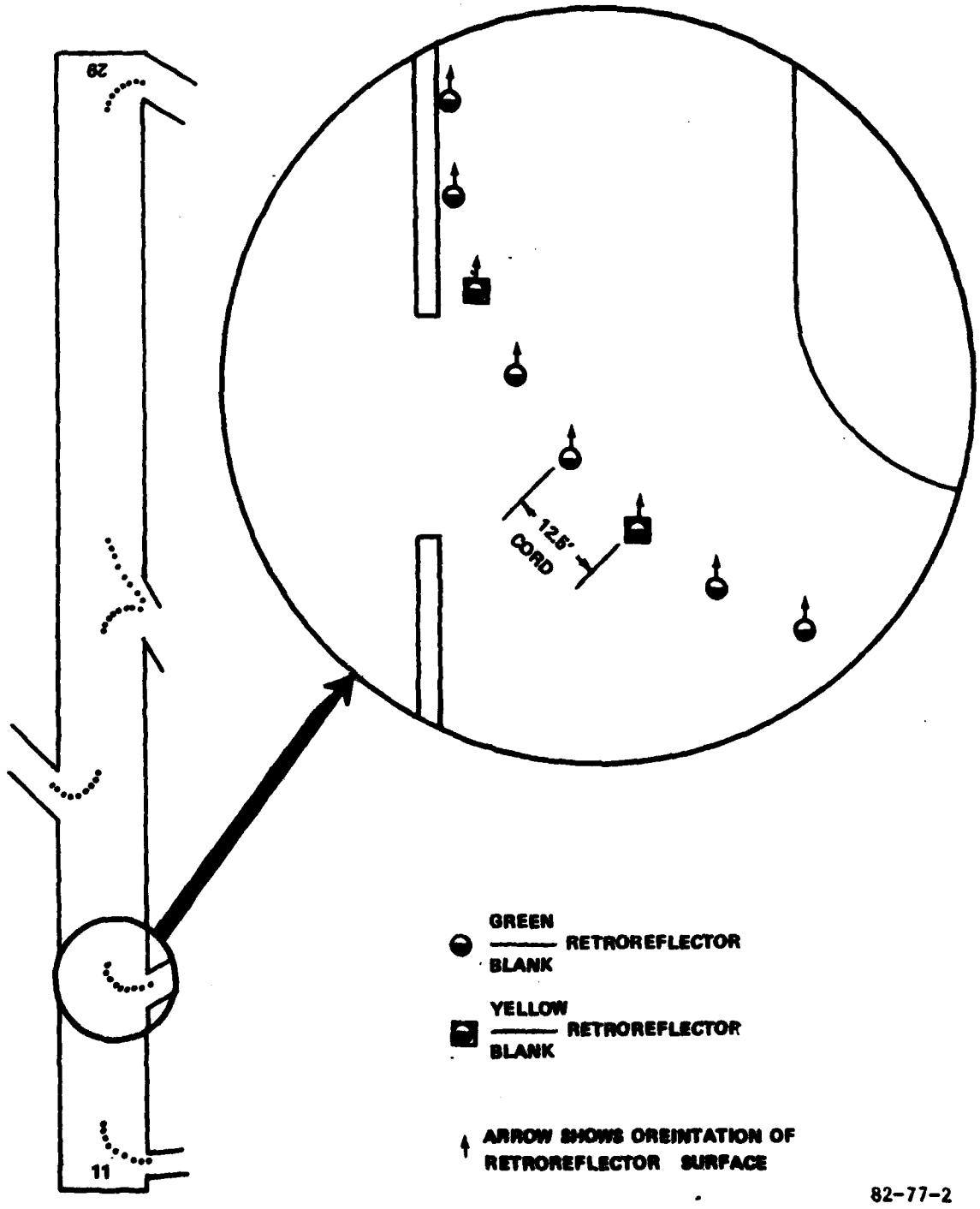

FIGURE 2. PROPOSED RETROREFLECTOR CONFIGURATION AT ACY

APPENDIX

Attention: All Pilots

EVALUATION OF RETROREFLECTIVE RUNWAY PAVEMENT MARKERS

Runway 4/22, Atlantic City Airport (ACY)

Retroreflective runway pavement markers, similar to those used on highways, have been installed on runway 4/22 for evaluation by the FAA Technical Center's Airport Technology Division.

The evaluation is to determine whether the retroreflective markers provide improved visual guidance to aid the pilot and improve the safety of nighttime operations, particularly during reduced visibilities with rain, fog and wet runway conditions.

Taxiway Exit Markers. Installed on runway 4 as an aid in identifying the exit at taxiway Bravo and on runway 22 as an aid in identifying taxiways Bravo and Delta.

Runway Centerline and Touchdown Zone Markers. Installed on runway 4 (to duplicate the standard runway centerline and touchdown zone lighting configuration used for runways approved for Category II operations), as an aid for takeoff, approach, landing, and rollout on the runway.

Completion of the attached questionnaires would be gratefully appreciated. Please return to the box located on the Operations Desk.

Thank you for your cooperation.

EVALUATION OF RETROREFLECTIVE RUNWAY PAVEMENT MARKERS

Runway 4/22, Atlantic City Airport (ACY)

Type and Model Aircraft_____ Date_____

Location of Taxi/Landing Lights Used: Wind_____

Nose___ Wing ___ Both ____ Other_____Pavement: Wet___ Dry___

Visibility:

<1 Mile ___ 1 to 2 Miles___ 2 to 3 Miles ____ >3 Miles ____

Precipitation/Visibility Restrictions:

Rain___ Snow___ Fog___ Haze or Smoke___ None____

Exit Taxiway Retroreflectors

Runway Used: Taxiway Used to Exit Runway:

Rwy. 4___ Rwy. 22____ T/W Bravo____ T/W Delta____

How much help were the reflective markers in finding the exit taxiway?

No Help____ Some Help____ Great Help____

Centerline and Touchdown Zone Retroreflectors

For the type aircraft and weather conditions experienced, please answer the following questions.

1. Please rate the effectiveness of the markers during the:

   a. Approaches Excellent ____ Good ____ Fair ____ Poor ____
   b. Flare & Touchdown Excellent ____ Good ____ Fair ____ Poor ____
   c. Landing Rollout Excellent ____ Good ____ Fair ____ Poor ____
   d. Takeoff Excellent ____ Good ____ Fair ____ Poor ____

   Comments:

2. During crosswind conditions, were you able to decrab sufficiently early during the approach to illuminate the pavement markers?

   a. Yes____ No_____
   Comments:

Continued on next page.

3. Did you find the red/white and all red coded centerline markers useful in determining distance remaining on the runway?

   Comments:

4. How would you rate the landing lights on your aircraft as to:

   a. Illumination/ Brightness — Excellent ____ Good ____ Fair ____ Poor ____
   b. Aiming — Excellent ____ Good ____ Fair ____ Poor ____

5. Considering the weather conditions encountered, do you feel that the additional guidance provided by the retroreflective markers improved the safety of operations during:

   a. Takeoff? — Yes ____ No ____
   b. Approach? — Yes ____ No ____
   c. Flare & Touchdown — Yes ____ No ____
   d. Landing Rollout? — Yes ____ No ____

   Comments:

Please include any additional comments or remarks:

Name_____

(Optional)*
Organization* _____

*Name and Organization will not be used when test results and comments are reported.


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